BTL-5000 Electrotherapy

USER'S GUIDE

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CONTENTS

1 GENERAL EFFECTS OF ELECTROTHERAPY

Electrotherapy is one of widespread types of physical therapy (PT). When correctly indicated and applied it is very effective. However, it cannot be lifted out of the context of comprehensive therapy, neither regarded as a cure-all.
Most of the physical procedures have similar effects and, depending on the parameters, some of them may be dominant. The main effects are:

- analgesic,
- myorelaxation, trophic and antiedematous.

By selection of a procedure and its parameters you can select one of the above stated effects or their combination.

P.S. An important note about continuing education

Continuing education is a very important aspect of healthcare delivery. Many excellent resources are today available to expand a user's knowledge about many aspects of electrical stimulation therapy. BTL recommends a thorough review of this guide prior to operating the equipment and a search of educational reading material on the internet.

2 CLASSIFICATION OF ELECTROTHERAPEUTIC CURRENTS

2.1 GALVANIC CURRENT

Galvanic current (or “continuous”) is current of constant intensity. It is always DC. It is used mostly for iontophoresis, or its trophic stimulative (hyperaemic) effect is utilized. A big disadvantage of the galvanic current is the risk of chemical damage of the tissue under the electrodes. The damage may be caused by the hydrochloric acid which originates under the anode or by the soda lye which originates under the cathode. Similar danger of the tissue damage can occur also at any direct current (e.g. diadynamic). **Direct currents must not be used for the patients with metallic implants!**
At present this current is often substituted by galvanic intermittent current. This current has the same effects (galvanic component is 95 %) but thanks to interrupting of the originally continuous intensity by the frequency 8 kHz it is better tolerated by the patients. It is suitable especially for iontophoresis.

2.2 PULSE DIRECT CURRENT

The pulse direct current is current of variable intensity but only one polarity. The basic pulse shape may vary. It includes e.g. diadynamics (combination of pulse DC – "dosis" and galvanic current – "basis"), rectangular (e.g. Träbert current), triangular and exponential pulses of one polarity.
Depending on the used frequency and intensity it has the stimulation, trophic and analgesic effects. Generally, direct current with variable intensity implies the same risks as galvanic current (corrosion of the skin surface) and therefore it requires careful observance of correct procedure, especially the correlation between the applied intensity and the length of application.
The main effect is the stimulation which is important especially below the cathode (green negative electrode).

2.3 ALTERNATING CURRENT

In comparison with DC, alternating current is safer and better subjectively tolerated by the patient. The basic pulse shape again may be various – rectangular, triangular, harmonic sinusoidal, exponential or combined. It can be alternating, symmetric or asymmetric. The DC component is always zero, which prevents from chemical damage of the skin under the electrodes.
Therefore this current enables also long-lasting applications, even for the patients with metal implants. Implanted electronic stimulators such as pacemakers etc. are indeed absolutely contraindicated. Nowadays the low-power pulses – TENS (Transcutaneous Electrical Nerve Stimulation) and interference – gain ground among the alternating currents. Use of alternating currents in the contact electrotherapy implies much lower stress on the tissue under the electrode.
For these types of current the capacitive component of skin resistance is involved, and also thanks to it these currents are very well tolerated by the patients.
In general:

- short duration of the pulse improves the subjective perception,
- the zero average value (DC component) prevents from chemical damage of the tissue,
- frequency and amplitude are responsible for the required therapeutic effect.

2.3.1 TENS

TENS = **t**ranscutaneous **e**lectrical **n**erve **s**timulation
Nowadays very prevalent group of currents which substitutes the standard applications of diadynamic currents, Russian stimulation, etc. TENS pulses are low-power and have zero DC component. Therefore, besides suppression of chemical damage of the tissue, the risk of electric damage of the tissue is also minimized.
As can be seen from their name, these currents are intended for stimulation of nerve stems or nerve fibres. Their major utilization is in alleviation of pain, inhibition of itching, etc. The mechanism of their effect is most often explained by the so-called gate theory of pain. Besides treating of pain, these currents can be also effectively utilized in electrogymnastics (stimulation of non-denervated muscles).

2.3.2 Classic (Four-pole) Interference

Four electrodes are located crosswise. Two frequency signals with different frequencies f_A and f_B are brought to the tissue. Their interference in the tissue induces a low-frequency surge in the centre of the cross; its frequency is:

AMF = $f_A - f_B$.

This surge of the frequency AMF has therapeutic effect, both basic currents of the frequency f_A and f_B are used only for "transport" of the AMF surges to the tissue. The f_A frequency is constant, changes of the f_B frequency by the value of so-called Spectrum serve for change of the resulting frequency AMF to the frequency AMF + Spectrum. Interference has similar effects as the low-frequency currents although it is carried by current of higher frequency and does not stress the tissue under the electrode so much. The carrier frequency of channels ranges from 3.5 to 10 kHz. The higher this frequency, the better is it tolerated by the patient. The advantage of the four-pole interference is the in-depth aiming of the treated area and lower stress on the superficial skin. Therefore there can be set higher intensity values than for the two-pole application.

2.3.3 Two-pole Interference

According to the new recommended terminology, these groups should be called "bipolar-applied amplitude-modulated mid-frequency currents"; however, owing to the length of this name we are keeping to the original one.
The resulting low-frequency current of the frequency AMF (or AMF + Spectrum) is created by the equipment. Therefore two electrodes are sufficient for its application. The absolute intensity values that can be reached are lower than for the classic interference (this current is worse tolerated by the patient than the classic interference) and at the same time the stress on the skin surface is higher than for the classic interference.
Its advantage is that it can be applied by the point electrode and thus it can be effectively used in combination with therapeutic ultrasound.

2.3.4 Isoplanar Interference

A special form of the four-pole interference where the additional modulation of both channels enables to distribute the treated area to the whole space of the current circuits' interlacement. It implies that placing of individual electrodes is much easier – those do not need to form a perfect cross anymore. The effect of these currents is very diffuse, in-depth and delicate.

2.3.5 Dipole Vector Field

Additional phase and amplitude modulation of basic signals of the four-pole interference enables to achieve the only one direction of the electric field's acting (so-called dipole is created in the tissue). In the direction of this dipole, the modulation of the field reaches up to 100 %, in the other directions it is almost zero. You can either rotate this dipole (abscissa) manually, and thus precisely aim the required effect of the therapy at the treated tissue, or let it rotate automatically.

3 EFFECTS OF ELECTROTHERAPY

3.1 ANALGESIC EFFECT

Pain is a multi-factor phenomenon and the practice positively shows that various types of pain respond more or less well to various physiotherapeutic, i.e. also electrotherapeutic procedures. There are several mechanisms of the analgesic effect of electrotherapy – besides the well-known *gate theory* of pain there is also proven increase of *production of endogenous opiates*. The analgesic effect is also supported by trophic effects of the flowing current. Timely *myorelaxation* removes the muscular hypertone and thus also pain of myofascial origin. Since the analgesic effect of electrotherapy is fundamental and most utilized it shall be described in a little more details.

Pain is usually simply defined as an unpleasant sensuous and emotional experience connected with actual or potential damage of the tissue. We usually distinguish between acute and chronic pain. Acute pain is short-lasting (maximum several days or weeks). It is caused by mechanical damage of the tissue or by a disease, comes immediately after the painful stimulus and subsides after its ending; the intensity of pain depends on the intensity of stimulation. On the other hand, chronic pain is long-lasting (more than 3 months) or it recurs; its intensity does not depend on the intensity of stimulation; emotions particularly play a leading role.

The now generally accepted theory of perception of pain is based on the assumption of existence of a specific sensory system which transfers information from receptors of pain (nociceptors) to the central nervous system by preformed special nerve paths. However, the process is in fact much more complicated and persons interested can learn about it from the available specialized literature.

To understand the effects of electrotherapy it is important to understand especially the modulation factors which can influence the perception and transfer of the painful stimulus:

- First crucial modulation factor is described by the so-called gate theory of pain which is based on the presumption that the nervous mechanism in posterior medullary horns act as a small gate which lets through only limited flow of nervous impulses from the peripheral afferent fibres to the central nervous system, depending on how much it is opened. Stimulation of some particular fibres can modulate the extent of the gate's opening or closing for pain and thus also increase or decrease transfer of the nociceptive information. A similar gate system is supposed to exist also on the level of thalamus.
- The other important modulation factor is described by the neuromodulation theory which is based on the analgesic effect of some substances belonging to the group of so-called neuromodulators, especially endorphins and encephalins. These substances are produced in the central nervous system and according to the mentioned theory they have crucial importance especially for subjective perception of pain.

Anyway, the analgesic effect of electrotherapy is used most often. To make PT a real benefit for the patient, it is necessary to observe the following principles:

- Do not suppress the signalling and protective function of pain (which is especially important for acute pain!), i.e. at first decrypt the information being signalled by the pain, properly determine the diagnosis or at least a preliminary hypothesis and only then intervene against the pain. Pain modified by PT or analgesics can loose its specificity insomuch that later it cannot be decrypted.
- Together with application of analgesic PT it is necessary to considerably reduce administering of analgesics. This rule is very important, owing to the possibility of relatively precise aiming of the analgesic effect of PT (in contrast to the unaimed effect of medicaments) and possible undesired interaction between PT and the medicaments.
- When choosing the type of PT consider the expected effect (gate theory, endorphins).
- For chronic or recurrent complaints do not obstinately apply various types of PT, but examine the locomotive system (or get it examined by a specialist) – very often the source of these complaints is far from the place of projection of pain (catenation-generalization).

For stimulation of thick, myelinized nerve fibres of A beta and delta types (gate theory) it is suitable to use low-frequency currents of the frequency 50 - 150 Hz (optimum 100 Hz) and intensity at or above threshold sensitivity. This method is effective especially for acute and segmentally localised pains. For chronic painful syndromes it is most suitable to use low frequencies 2 - 8 Hz and intensity at the highest tolerable level (up to the threshold of pain); thus thin fibres of C type are stimulated (creation of endorphins). For achievement of combination of both above-stated mechanisms of easing of pain use the "burst modulation". The carrier frequency should be about 100 Hz, burst frequency up to 10 Hz (even frequencies lower than 1 Hz are not exceptional). Currents with burst modulation bring the cumulated analgesic effect. By the depth of the required effect the procedures can be ordered as follows (from the most superficial to the deepest ones):

- analgesic effect of anelectrotonus (galvanic current)
- diadynamic currents LP and CP-ISO
- Träbert current

- TENS
- 2-pole interference (amplitude-modulated mid-frequency currents),
- 4-pole interference, isoplanar interference and vector fields

3.2 MYORELAXATION AND SPASMOLYTIC EFFECT

Especially after the posturographic examination had proved that overall administering of so-called myorelaxancies has a negative long-term influence on the body posture, the possibility of exact aiming at the hypertonic muscle has been regarded as an especially valuable advantage of myorelaxation procedures. At overall application of myorelaxancies there are first affected the phasic muscles which have been already weakened due to the layer syndrome. Later, or when stronger dose is applied, there are also affected the tonic muscles and only at the end, at the strongest dosage, also hypertonic muscles are positively affected. This effect lasts for several weeks and affects the static of the spine very negatively even after the acute complaints have subsided.
Procedures with myorelaxation effect include therapeutic ultrasound, 2-pole interference with contour frequency 100 – 200 Hz, 4-pole interference currents and high-voltage therapy in the same frequency modulation band. For small superficial muscles especially on hands also paraffin can be used.
A favourable side effect of myorelaxation is also the analgesic effect.

3.3 TROPHIC EFFECT

is caused by hyperaemia which occurs in almost all types of PT (except cryotherapy). Since the mechanism of hyperaemia in various types of PT is different, it is necessary to take these mechanisms into account so as to be able to select the particular PT. Generally, galvanization can be recommended, especially longitudinal (capillary hyperaemia, vessel eutonisation), low-frequency currents of the frequency 30 - 60 Hz and the intensity at or above the threshold motor activity level (muscle micropump) or ultrasound, laser, polarized specified achromatic light, vacuum-overpressure therapy, etc.
The trophic effect may be partly caused by the fact that most forms of PT, esp. laser, biolamp and magnetotherapy, bring energy into the organism, to be used by cells (or other structures) for their activity.
The trophic hyperaemic effect is also usually connected with the analgesic effect.

3.4 ANTIEDEMATOUS EFFECT

is practically connected with hyperaemia, vessel eutonisation and higher capillary permeability. Therefore the therapies referred to as trophic are also antiedematous (see the previous paragraph).

3.5 PLACEBO EFFECT

Opponents of the physical therapy tend to refer to its effects as placebo.
If PT is applied accidentally, without knowledge of its mechanism, accurate aiming and dosage (as it often happens), its effects can be called like this. Exact verification of the effects of PT faces many troubles.

- Owing to the fact that *lege artis* application of PT requires to take into account especially the patient's individuality and momentary functional status (including the limbic system status, mood, muscular tonus, season of the year, weather, motivation, attitude to the troubles, etc.) it is almost impossible to create a group for further statistical processing. Creation of a control group is practically out of question.
- The effect of PT lies almost only in affecting of the afferent system. The afferent system processes all data, including the visual, auditory, tactile and other analysers. Since very often a slight stimulus is sufficient to deviate the organism from the existing functional balance (even the pathological one) and, using its enormous self-reparation abilities, the organism helps itself, there cannot be carried out e.g. a blind experiment without at least minimum excitation of an afferent system and/or higher components of CNS.
- Functional defects of the locomotive organs which belong to the main positive effects of PT tend to self-repair, if they are not prevented from that (e.g. by inappropriate pharmacotherapy). If correctly indicated, PT both initiates and accelerates this self-reparation, which indeed can be hardly exactly proved.

3.6 DEFERRING EFFECT

A "troublesome" patient is often invited for the check examination only after undergoing of usually ten procedures and "hopefully will be better then". This way of thinking is immoral, unethical and discreditable to a specialist, but nevertheless most of the existing prescriptions of PT unfortunately belong to this category. In some surgeries the patients are even told that the effect of the chosen PT will come only after several months (!), which means that the physician fully relies on the organism's self-reparation abilities.
Indication of PT then should not be based only on the diagnosis, especially if the diagnosis is confusing, e.g. periarthritis humeroscapularis etc.
The attending physician should know the answers to the following questions:

- What is the cause of the complaints, i.e. usually pain?
- Is the defect functional or organic?
- Where was the defect initiated – where is (are) the key area(s)?
- Which of the above-mentioned effects of PT is the most important for the patient at the moment?
- Is there not a risk of aggravation or organification of the functional defect after the chosen PT?

By these answers the physician should choose the type, location, intensity, frequency and total number of treatments, and, in relation to them, also the date of the check examination of the patient.

3.7 CONTRAINDICATIONS FOR ELECTROTHERAPY

- active TB
- allergy to the solutions used for moistening of the electrode sponge covers
- application in the area of heart or eyes
- pacemaker
- cardiovascular diseases
- cochlear implants
- metal implants and/or malignancies in the current path
- skin defects and inflammations
- bleeding
- menstruation
- tumours
- defects of sensitivity in the point of location of the electrode
- psychopathological syndromes and organic psychosyndromes
- multiple sclerosis
- pregnancy
- inflammations of veins and lymphatic paths

3.8 SYMBOLS OF EFFECTS A-E-T-R-S

Symbols of effects of therapy used in the equipment have the following meaning:

A - analgesic
E - antiedematous
T - trophic
R - myorelaxation
S - myostimulation

4 SETUP AND CONTROL OF ELECTROTHERAPY

4.1 COMMON PARAMETERS

4.1.1 Output Mode

CC (= constant current) mode – in this mode the current flowing through the patient is constant, regardless of impedance of the patient's tissue. Owing to physiological effects during electrotherapy the impedance of the tissue decreases, which in the normal course of events causes spontaneous rise of the current flowing through the patient which can be unpleasant. The CC mode is therefore useful for most of the static applications with fixed electrodes (including e.g. the suction cups).
However, if you want to use point electrodes, combined therapy with ultrasound head, moving electrodes (e.g. roller) etc., it is suitable to switch over to the **constant voltage mode** because moving of the electrode in the current mode would cause temporary reduction of the contact area between the electrode and the patient's skin and consequently significant rise of the current density, which could be painful for the patient.
Similarly for the therapies where muscle contractions are expected and/or electrodes could slightly move on the skin it is suitable to select the **constant voltage mode** of stimulation.

CV (= constant voltage) mode – in this mode the voltage on the electrodes is constant. Owing to physiological effects the current in the tissue may slightly rise during therapy and therefore it is usually necessary to adjust the set intensity according to the patient's feelings, approximately every one or two minutes. Still this mode is suitable especially in the cases where the CC mode would bring problems – pain and reduction of output intensity – i.e. at the applications with moving electrodes and at the applications which are accompanied by muscle contraction.

4.1.2 Polarity

- **positive polarity**: socket marked "+" is anode (use the cable with red banana plugs)
  socket marked "-" is cathode (use the cable with white or black banana plugs)
- **negative polarity**: the polarity of sockets is reversed ("+" = cathode; "-" = anode)
- **positive, reversal**: the first half of therapy has positive polarity of signal, in the middle of therapy the polarity automatically changes to negative
- **negative, reversal**: the first half of therapy has negative polarity of signal, in the middle of therapy the polarity automatically changes to positive
- **pos., rev. with interrupt.**: the first half of therapy has positive polarity of signal, in the middle of therapy the polarity automatically changes to negative; at the change the equipment interrupts therapy and waits for re-setting of correct intensity
- **neg., rev. with interrupt**: the first half of therapy has negative polarity of signal, in the middle of therapy the polarity automatically changes to positive; at the change the equipment interrupts therapy and waits for re-setting of correct intensity

4.1.3 Therapy Time

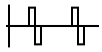
can be set within the range from 00:01 to 99:59 [min:sec].

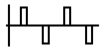
4.1.4 Physiological Effects

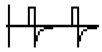
characterize particular diagnoses and programs and can be adjusted. For the meaning of particular symbols see chapter **3.8 Symbols of Effects A-E-T-R-S**.

4.2 TENS

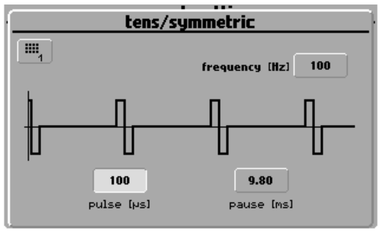
4.2.1 Type


symmetric – the positive pulse is immediately followed by the negative one


alternating – the positive pulses regularly alternate with the negative ones


asymmetric – positive rectangular pulses are followed by exponential pulses of negative polarity. Nowadays the most widespread type of TENS, probably because of its favourable effects which are similar to those of DC pulses, and electrochemical properties corresponding to AC.

4.2.2 Pulse, Frequency, Pause



In this dialog box it is possible to set basic parameters of the generated TENS – TENS pulse length, pause between TENSes or TENS frequency. All these three parameters are mutually related by the following mathematical relations and therefore at change of one parameter the other ones can change too:

symmetric TENS:

frequency = 1 000 000 / (2 * **pulse** + 1000 * **pause**) [Hz; μs, ms]

alternating TENS:

frequency = 1 000 000 / (2 * **pulse** + 2000 * **pause**) [Hz; μs, ms]

asymmetric TENS:

frequency = 1 000 000 / (7 * **pulse** + 1000 * **pause**) [Hz; μs, ms]

Note: The relations are based on the electric waveform of TENS and the way of their generating.

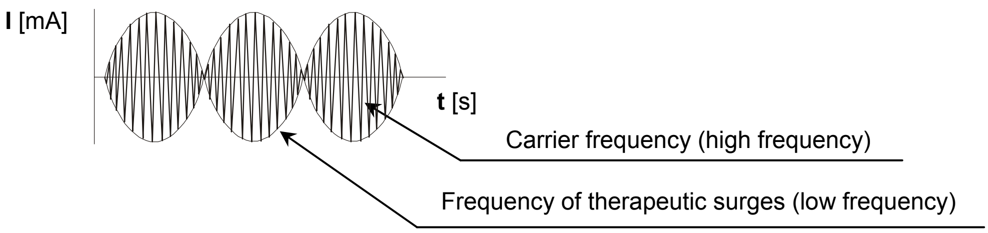
4.2.3 Electro Parameters

For details see **4.13 Pulse Modulation**.

4.3 2–POLE, 4–POLE, ISOPLANAR AND DIPOLE INTERFERENCE

4.3.1 Carrier Frequency

Frequency of the "carrier" which "transports" to the tissue (for the two-pole interference) or creates in the tissue (for the four-pole interference) a low-frequency therapeutic surge.



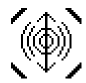
4.3.2 Electro Parameters

For details see **4.14 Interference – parameters**.

4.3.2.1 Isoplanar Interference – "Field Rotation"

Isoplanar vector field is a special form of four-pole interference where amplitude modulation of both channels causes the even, almost 100 % modulation in the entire area of current circuits intersection. The nature of these regular amplitude changes of channels corresponds to "rotation" of the whole field. This parameter should be best set to the value which equals to the entire sweep time (for the continuous and jump sweep it is the sum of all set times, for the symmetric sweep set the rotation time equal to the sweep time).

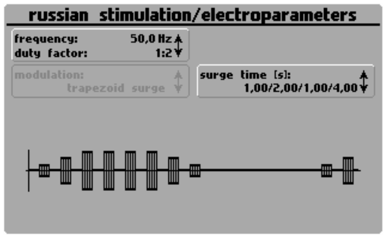
4.3.2.2 Dipole Interference – Dipole Rotation



For the dipole vector field with automatically rotating dipole you can set the speed of rotation of this dipole in the area of intersection of current circuits.
In the direction of the dipole the depth of modulation is always maximum, in the other directions it is minimum.

4.4 RUSSIAN STIMULATION

4.4.1 Carrier Frequency



Frequency of the "carrier" which "transports" low-frequency therapeutic pulses to the tissue – similarly as for the two-pole interference where the carrier transports there low-frequency surges.

4.4.2 Pulse Frequency, DF

In this dialog box it is possible to set the **frequency of low-frequency pulses**.
DF (duty factor) parameter is the ratio of the pulse length to the length of the pause between pulses.

4.4.3 Pulse Length (Electro Parameters)

In this dialog, which is similar to that for setting of trapezoid surges – see **4.13.5 Trapezoid Surges**, it is possible to set the rise time of amplitude of low-frequency currents, time of stimulation, fall time and time of relaxation.

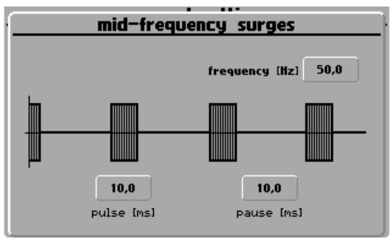
4.5 MID-FREQUENCY SURGES

These stimulation pulses are in principle similar to Russian stimulation but have wider portfolio of possibilities of individual settings.

4.5.1 Carrier Frequency

See **4.4.1 Carrier Frequency**.

4.5.2 Pulse, Frequency, Pause



In this dialog box it is possible to set the basic parameters of generated pulses – length of pulse of the mid-frequency surge, pause between pulses and pulse frequency. All these three parameters are mutually related by the following mathematical relation and therefore at change of one parameter the other ones can change too:

frequency = 1 000 / (**pulse** + **pause**) [Hz; ms, ms]

The limits of setting of the individual parameters are determined by the carrier frequency.

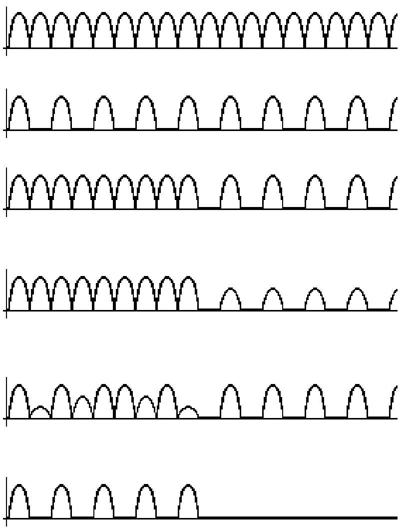
4.5.3 Electro Parameters

The parameters to set are the same as for most of the basic stimulation pulses. For details see **4.13 Pulse Modulation**.

4.6 DIADYNAMIC CURRENTS

4.6.1 Type

The basic types of diadynamic currents are as follows:



DF: basic diadynamic pulses of the frequency 100 Hz or 120 Hz – "two-way-rectified mains frequency" (according to the mains frequency 50 / 60 Hz)

MF: basic diadynamic pulses of the frequency 50 Hz or 60 Hz – "one-way-rectified mains frequency" (according to the mains frequency 50 / 60 Hz)

CP: diadynamic pulses created by combination of types **DF** and **MF**, the pulses alternate every 1 second for the basic frequency 50 Hz and every 1.2 second for the basic frequency 60 Hz

CP-ISO: the same combination of pulses **DF** and **MF**, but the mutual intensity of currents is equalized by the base-line (owing to the difference in perception of DF and MF, intensity of the MF current is 11 % lower than that of the DF current)

LP: diadynamic current with smooth transitions between **DF** and **MF** surges. The whole change of the MF surge to DF and back to MF lasts 10 or 12 seconds and the length of the MF surge is 6 or 7.2 seconds (according to the basic frequency 50 Hz / 60 Hz)

RS: diadynamic current combined of the **MF** current (time 1 or 1.2 second) and a pause (length 1 or 1.2 second – according to the basic frequency 50 / 60 Hz)

4.6.2 Base

To the pulse component of the diadynamic current there is added the **galvanic component – base**. It can be defined proportionally – the base component represents the set percentage of the total intensity.

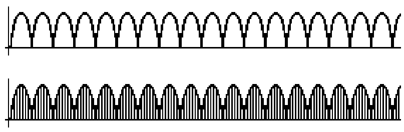
4.6.3 Electro Parameters

4.6.3.1 Basic Frequency

Basic frequency which the diadynamic pulses are derived from. It is based on the frequency of the mains – for the countries with the mains frequency 50 Hz (Europe, Asia) set the option **50 Hz / 100 Hz**; for the countries with the mains frequency 60 Hz you can use the option **60 Hz / 120 Hz**. You can select the option according to your practice, but please note that the original basic frequency of diadynamic currents was 50 Hz (these currents were discovered accidentally by the dentist Bernard in France – see PODĚBRADSKÝ, J., VAŘEKA, I. *Fyzikální terapie I.*. Praha: Grada, 1998.)

4.6.3.2 Interruption

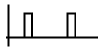
This option switches on the "momentary interruption" of the generated waveform. The length of the interruption is **5 μs** and the repeating frequency of interruption is **8000 Hz**. As for power there is no change in the generated waveform (duty factor is 96 %) but the patient's tolerance is higher.



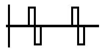
4.7 PULSES: RECTANGULAR, TRIANGULAR, EXPONENTIAL AND WITH EXPONENTIAL RISE, COMBINED, INTERRUPTED

4.7.1 Type

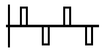
monophasic – pulses of only one polarity (ATTENTION! These pulses have galvanic effect!)



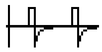
symmetric – the positive pulse is immediately followed by the negative one



alternating – the positive pulses regularly alternate with the negative ones

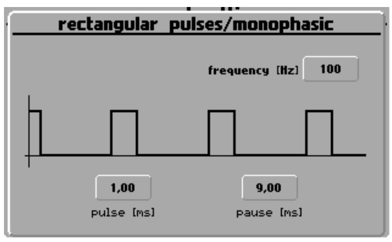


asymmetric, combined - positive rectangular pulses are followed by exponential pulses of negative polarity. Their effects are similar to those of DC pulses but the electrochemical properties correspond to AC.



4.7.2 Pulse, Frequency, Pause

In this dialog box it is possible to set the basic parameters of generated pulses – pulse length, pause between pulses and pulse frequency. All these three parameters are mutually related by the following mathematical relations and therefore at change of one parameter the other ones can change too:



monophasic pulses:
frequency = 1 000 / (**pulse** + **pause**) [Hz; ms, ms]
symmetric pulses:
frequency = 1 000 / (2 * **pulse** + **pause**) [Hz; ms, ms]
alternating pulses:
frequency = 1 000 / (2 * **pulse** + 2 * **pause**) [Hz; ms, ms]
asymmetric pulses:
frequency = 1 000 / (**pulse** + 7 * **pause**) [Hz; ms, ms]

Note: The relations are based on the electrical waveform of the pulses and the way of their generating.

4.7.3 Electro Parameters

For details see **4.13 Pulse Modulation**.

4.8 STIMULATION PULSES

4.8.1 Type

The two basic types suitable for stimulation are **rectangular** and **triangular**.

4.8.2 Pulse, Pause

The setup dialog is similar to that in **4.7.2 Pulse, Frequency, Pause**, but it is possible to set only the pulse length and pause length. For correct stimulation by individual pulses it is recommended to keep the following relation:

$t_{PAUSE} = 0.003 * t_{PULSE}$ [s; ms]

4.8.3 Electro Parameters

4.8.3.1 Sound Signal

The sound signal indicates the moment of generation of the stimulation pulse. Possible settings:
beep – the length of beep corresponds to the length of the generated pulse
click – short "click" indicates the beginning of the generated pulse
no sound.

4.9 TRÄBERT CURRENT, LEDUC CURRENT, FARADIC CURRENT, NEOFARADIC CURRENT, H-WAVES

Special types of pulse currents, for their parameters see chapter **Technical Parameters**.

4.10 GALVANIC CURRENT

4.10.1 Type

Continuous or **interrupted**. The length of interruption is **5 μs**, repeating frequency is **8000 Hz**.

4.11 MICROCURRENTS

are designed for application by tip or point electrode.

4.11.1 Type

The waveforms of the particular current types are best illustrated in the following table :

rectangular monophasic		
rectangular symmetric		
rectangular alternating		
triangular monophasic		
triangular symmetric		
triangular alternating		
exponential monophasic		
exponential symmetric		
exponential alternating		
combined		

4.11.2 Pulse, Frequency, Pause

This dialog is the same as the dialog **4.7.2 Pulse, Frequency, Pause** for standard pulses.

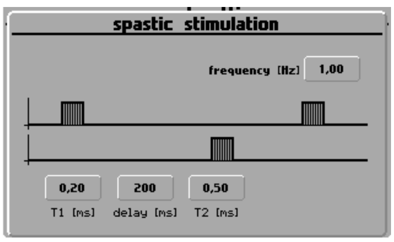
4.11.3 Electro Parameters

For details see **4.13 Pulse Modulation**.

4.12 SPASTIC STIMULATION

4.12.1 Pulse, Delay, (Frequency)

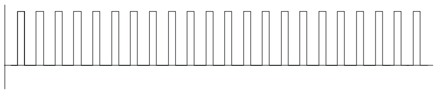
It is possible to set the length of **T1** pulses, which are generated by channel E1, the length of **T2** pulses, which are generated by channel E2, delay between pulses T1 and T2 and repeating frequency of pulses.
It is also possible to set independently the polarity of pulses **T1** and **T2** – see buttons **polarity 1** and **polarity 2**.



4.13 PULSE MODULATION

4.13.1 Constant Frequency

The set current has no supplementary modulation and is not further influenced. See picture – rectangular pulses.



4.13.2 Random Frequency

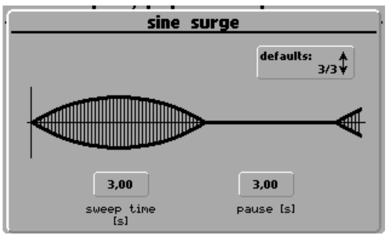
During generation the frequency of the generated current randomly changes within the range approx. ± 30 %. See the picture with random "compression" of rectangular pulses.

4.13.3 Burst

Low-energy group of several pulses following immediately one after another. It is possible to set the **number of pulses in burst** and **frequency of bursts** [Hz]. For information there is calculated the *pause between bursts [ms]* and *burst length [ms]*. It is also possible to choose from several **pre-defined values**.

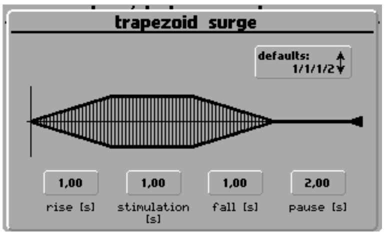
4.13.4 Sine Surges

High-energy group of pulses which can cause e.g. a muscle contraction. It is possible to set the **sine surge length** [s] (= stimulation time) and **pause between surges** [s] = relaxation time.
It is also possible to choose from several **pre-set values**.



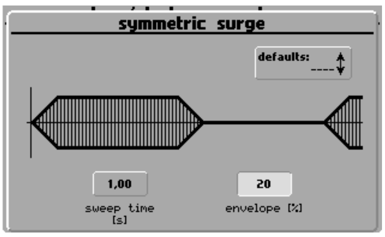
4.13.5 Trapezoid Surges

High-energy group of pulses which can cause e.g. a muscle contraction. It is possible to set the **trapezoid surge rise time** [s] = time of rise of stimulation, **stimulation time** [s], **trapezoid surge fall time** [s] = subsiding of stimulation, and **pause between surges** [s] = relaxation time.
It is also possible to choose from several **pre-set values**.



4.13.6 Symmetric Surges

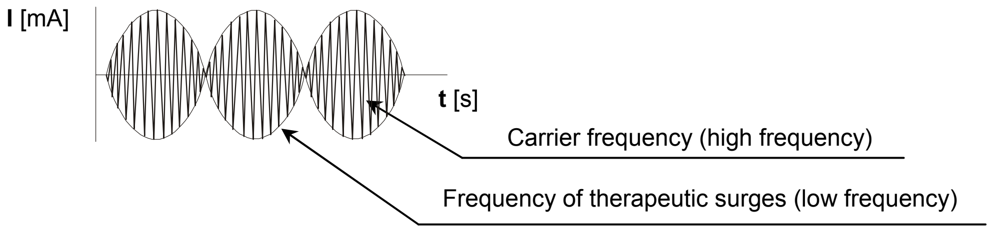
High-energy group of pulses which can cause e.g. a muscle contraction. It is actually a symmetric trapezoid surge with a different way of setting. It is possible to set the **sweep time** [s] – i.e. the stimulation and relaxation time, always including rise (or fall) time, and so called **contour** [%] – i.e. ratio between the actual stimulation time and the stimulation rise time. It is possible to choose from several **pre-set values**



4.14 INTERFERENCE – PARAMETERS

4.14.1 AMF and Spectrum

AMF is the basic frequency of therapeutic surges which is created in the tissue by interference (e.g. by combination of the signal of channel E1 with the signal of channel E2). This applies for the four-pole interference. For the two-pole interference the surges of the basic frequency AMF are directly "transported" to the tissue by the carrier.



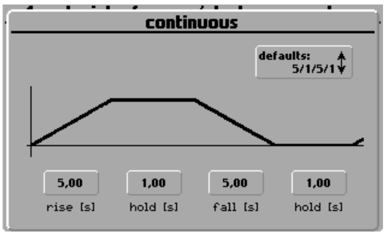
Spectrum determines the extent of change of the basic frequency of therapeutic surges – **AMF**. The resulting frequency of therapeutic surges then ranges from **AMF** to **AMF + Spectrum** and changes according to the set way of **frequency sweep**.

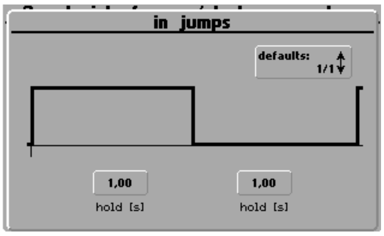
4.14.2 Frequency Sweep

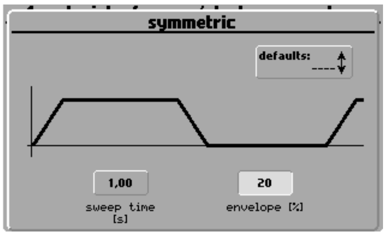
defines the ways of sweep of the resulting frequency of therapeutic surges between **AMF** and **AMF + Spectrum**:

- continuous (rise of frequency, upper hold, fall and lower hold)
- continuous, random
- in jumps (upper and lower hold)
- in jumps, random
- symmetric (time of change = "sweep time", "contour")
- symmetric, random.

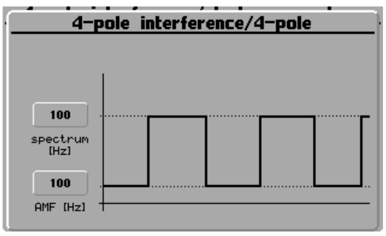
The differences among particular ways of sweep are displayed in the following pictures:



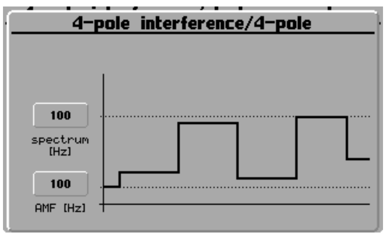




The difference between standard and random way of sweep is again best illustrated in the following two pictures. In the classic way of sweep the change of frequency always involves two values – **AMF** and **AMF + Spectrum**. In the **random way of sweep** the equipment selects the resulting generated frequencies randomly from the values between **AMF** and **AMF + Spectrum**. This way of sweep reduces the risk that the tissue gets used to the generated frequencies and thus in some cases it increases the success of therapy:



standard sweep

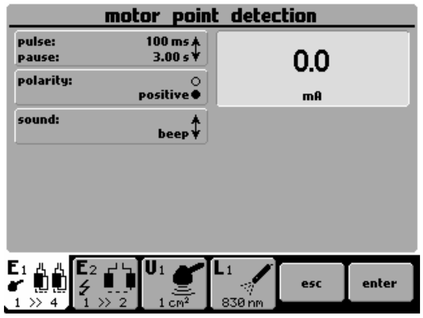


random sweep

4.15 ELECTRODIAGNOSTICS

4.15.1 Motor Point Detection

Before any electrodiagnostic measuring first find the motor point of the muscle, i.e. the point in which the muscle stimulation is the most significant – contraction is initiated by the lowest set value of intensity. You should also determine by which electrode (cathode or anode) the measuring will be done.

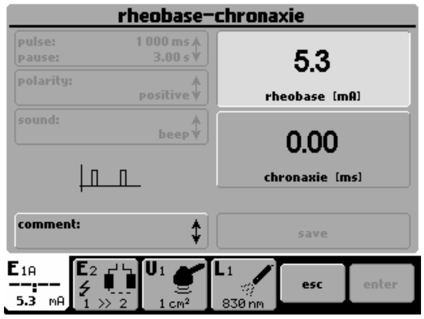


Anode – positive electrode (red banana plug) connect to the plate electrode as a reference electrode. This electrode shall be placed proximally or distally to the treated muscle. It is also possible to use suction cup electrode – continuous vacuum mode.
Cathode – negative electrode (black banana plug) is connected to the stimulation point electrode.

For finding the motor point it is recommended to use pulses of the length approx. **5 ms** for the healthy muscle and approx. **100 ms** for the denervated muscle. The pause between pulses should be **2 - 3 seconds**. After finding the motor point reverse the polarity of the output current (**positive** polarity → **negative,** or shift the electrodes – red banana plug to the point electrode and the black one to the reference electrode) and measure the muscle sensitivity for the reversed polarity of the signal (the stimulation electrode in this case is **anode**). For further stimulation use that connection of electrodes (polarity) for which the muscle is more sensitive.

4.15.2 Rheobase – Chronaxie

is measured in the motor point of the muscle by rectangular pulses, with the electrode polarity which was determined as more sensitive when detecting the motor point.



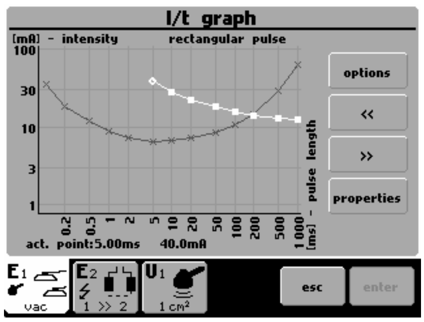
Rheobase is the lowest intensity of rectangular pulse current to initiate muscle contraction.
Chronaxie is the length of pulse which initiates muscle contraction and the intensity of which is 2x higher than rheobase.
The values of rheobase and chronaxie can be determined from the completely measured I/t curve – see chapter **4.15.4**, or can be measured by the following simplified method.
First measure the rheobase (length of the measured pulse is 1000 ms) and then the chronaxie. The equipment automatically sets the correct intensity of the measuring pulse – you set its length (by the **time / stop** knob: turn it to set the pulse length, press it to start or stop the stimulation). After finding of both values save the measured results.
It is recommended to write in the **note** if the stimulation point electrode was cathode or anode.

4.15.3 Accommodation Coefficient

is measured in the motor point of the muscle by a triangular and a rectangular pulse, with the electrode polarity which was determined as more sensitive when detecting the motor point.
Accommodation coefficient is a ratio between intensity of the triangular pulse and the intensity of the rectangular pulse. Pulse width is 1000 ms and pause between pulses is 3 seconds. First measure the rectangular pulse, after its measuring and saving by the **time / stop** knob (**17**) the equipment automatically switches to measuring by the triangular pulse. The set intensity is displayed in the upper box on the screen, the lower box displays the current measured value of the **accommodation coefficient with verbal diagnosis**.
It is recommended to write in the **note** if the stimulation point electrode was cathode or anode.

4.15.4 I/t Curve

is measured in the motor point of the muscle by a triangular or a rectangular pulse, with the electrode polarity which was determined as more sensitive when detecting the motor point.



4.15.4.1 I/t Curve – Options

This menu includes the following options:

- **edit point:** to set quickly and directly the pulse length and pause length

- **delete point:** to delete the measured point of the curve from the graph
- **new curve - rectangular pulses:** to add a new I/t curve to the graph to be measured by rectangular pulses
- **new curve - triangular pulses:** to add a new I/t curve to the graph to be measured by triangular pulses
- **delete curve:** to delete the curve from the graph
- **import curve:** to load an I/t curve from the equipment's memory to the graph
- **save curve:** to save the I/t curve
- **motor point detection**
- **calculation of chronaxie-rheobase:** active only if the graph displays only one curve
- **calculation of accommodation coefficient:** active only if the graph displays two curves – one measured by triangular pulses and the other by rectangular pulses
- **calculation of stimulation:** active only if the graph displays two curves measured by triangular pulses

4.15.4.2 I/t Curve – Properties

In this screen define the name of I/t curve and supplementary information and assign it to a patient.

4.15.4.3 I/t Curve – Measuring

To move along the time axis and change the length of the generated pulse turn the **time / stop** knob.
To set intensity of the generated pulse turn the **intensity** knob.
To insert the set value of intensity to the graph press the **time / stop** knob.
Plastic buttons **>>** and **<<** on the screen serve for selection which of the displayed I/t curves will be active – this curve will be then dealt with in the menu and during measuring, etc.

4.16 COMBINED THERAPIES

4.16.1 Polarity of Ultrasound Head

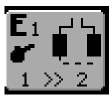
Polarity of the ultrasound head is set on the display:

- **anode (+)** – in this case select on the display for generator E1 (or on the electrotherapy display) the output polarity "**positive**"
- **cathode (-)** – in this case select on the display for generator E1 (or on the electrotherapy display) the output polarity "**negative**"

The other electrode to be connected to the patient is the reference electrode of the respective electrotherapy generator (standardly E1). This electrode is connected to the output **(-)** on the electrotherapy, preferably by the black cable.

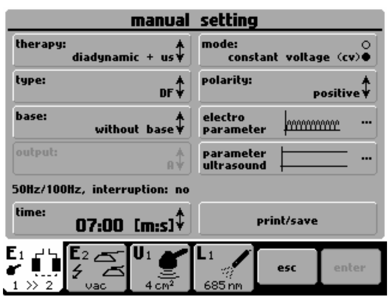
4.16.2 Setting of Parameters of Combined Therapy

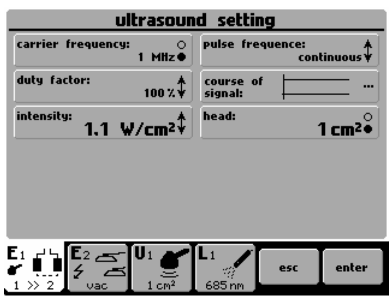
4.16.2.1 BTL-5000 Combi Devices



Combined therapies can be started from the electrotherapy generator with the symbol of ultrasound head on its tab – see picture. Usually it is the electrotherapy generator E1.
Only the lists of this generator contain combined therapies, including combined diagnoses, combined programs and manual selection of therapy.

After selecting the combined therapy (no matter if in the list of diagnoses – **diag**, the list of programs – **prog** or using manual control – **man**) the electro generator screen displays the standard electro parameters setup screen with the added "**parameters ultrasound**" button.





After pressing the "**parameters ultrasound**" button you can set all parameters of the ultrasound therapy as required. For detailed description of ultrasound parameters see the **Ultrasound Therapy User's Guide**.

4.16.2.2 Connected Devices BTL-5000 Pulse and BTL-5000 Sono

For the schematic drawing of interconnection of these devices see the **User's Manual**. The devices are controlled separately, therapies are run on each device individually. On the BTL-5000 Sono device start therapy on the generator U1 and check off the option "**with electro"**.

4.17 SPECIFIC ELECTROTHERAPY SETTINGS

4.17.1 Check of Contact of Electrodes

Here it is possible to disable (or enable) the check of contact of the electrodes with the patient's body during therapy. From the factory this function is ON. We recommend to disable it only if you want to use electrotherapy especially for motor stimulations.

4.17.2 Measuring of Electrodes

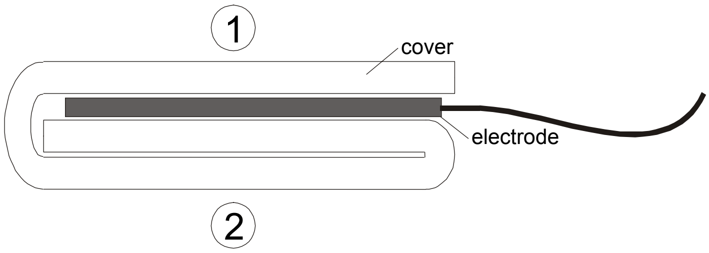
The electrodes which are applied to the patient's body during therapy are subject to ageing which proves itself by gradual growth of their resistance up to the level where further use is impossible (the device keeps displaying the message "bad contact of electrodes with the patient"). The usability time of the electrodes depends especially on the used types of currents.

This function serves for checking of quality of electrodes. The check starts after pressing of the "start/stop" button. The current status of electrodes is displayed in the bottom part. After switch-on press the electrodes against each other – then the device displays the text result.

5 RECOMMENDATIONS FOR ELECTROTHERAPY

5.1 USE OF PLATE ELECTRODES

The equipment can work with plate BTL electrodes. For plate electrodes use sponge covers moistened by water (or by therapeutic solution in case of iontophoresis). Before first use of the covers it is necessary to rinse them in tepid water. Moistening of covers or sponges prevents the patient from burning. When generating low-energy currents (TENS) apply side 1 of the electrode in the sponge cover to the patient's body. One ply of the sponge cover will be between the electrode and the patient's skin. For high-energy currents (recommended for all currents except TENS) apply side 2 of the electrode in the sponge cover to the patient's body.



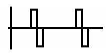
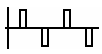
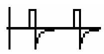
Before first use rinse the electrode sponge covers thoroughly in tepid water. From the manufacturing they are impregnated with special substance which prevents them from going mouldy.

After washing and drying the electrode covers harden. It is not a defect – after moistening they will get soft again.

6 TECHNICAL PARAMETERS OF ELECTROTHERAPY

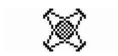
6.1 PARAMETERS OF PARTICULAR THERAPIES – CURRENTS

6.1.1 TENS

type: symmetric, alternating, asymmetric
pulse: 10 to 400 μs
pause: 0.15 to 2 500 ms (depending on the pulse length, pulse type and the set frequency)
frequency: 0.2 to 1 000 Hz (alternating)
0.4 to 1 000 Hz (symmetric, asymmetric)
modulation: see **Modulation of Currents** below

6.1.2 4-pole Interference

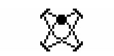


carrier frequency: 3 600 to 10 000 Hz
AMF: 0 to 200 Hz
Spectrum: 0 to 200 Hz
frequency sweep: see **Frequency Sweep** below

6.1.3 2-pole Interference

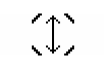
carrier frequency: 3 600 to 10 000 Hz
AMF: 0 to 200 Hz
Spectrum: 0 to 200 Hz
frequency sweep: see **Frequency Sweep** below

6.1.4 Isoplanar Interference



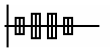
carrier frequency: 3 600 to 10 000 Hz
AMF: 0 to 200 Hz
Spectrum: 0 to 200 Hz
frequency sweep: see **Frequency Sweep** below
field rotation: 0.5 to 70 s

6.1.5 Interference - Dipole Vector

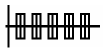
type: automatic, manual rotation
carrier frequency: 3 600 to 10 000 Hz
AMF: 0 to 200 Hz
Spectrum: 0 to 200 Hz
frequency sweep: see **Frequency Sweep** below
dipole rotation: from 3 rev. per second to 1 rev. per 30 seconds (auto-rotation)

6.1.6 Russian Stimulation



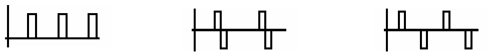
carrier frequency:	2 500 to 10 000 Hz
pulse frequency:	40 to 150 Hz
pulse/pause ratio:	1:1 to 1:8 (exception; otherwise the pulse/period ratio is used)
modulation:	trapezoid surges
	(for parameters see **Modulation of currents** below**)**

6.1.7 Mid-frequency Surges (Amplitude-modulated)



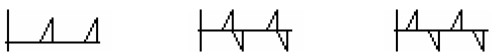
carrier frequency:	2 500 to 10 000 Hz
pulse:	0.1 to 50 ms (depending on the set carrier frequency)
pulse frequency:	9.8 to 1 000 Hz (depending on the set carrier frequency)
modulation:	see **Modulation of Currents** below

6.1.8 Rectangular Pulses



type:	monophasic, symmetric, alternating
pulse:	0.2 to 1 000 ms
pause:	0.1 to 10 000 ms (monophasic, symmetric; then by the pulse length)
	0.1 to 5 000 ms (alternating; then by the pulse length)
frequency:	0.1 to 1 000 Hz
modulation:	see **Modulation of Currents** below

6.1.9 Triangular Pulses

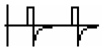


type:	monophasic, symmetric, alternating
pulse:	1 to 1 000 ms
pause:	0.1 to 10 000 ms (monophasic, symmetric; then by the pulse length)
	0.1 to 5 000 ms (alternating; then by the pulse length)
frequency:	0.1 to 900 Hz (monophasic)
	0.1 to 450 Hz (symmetric, alternating)
modulation:	see **Modulation of Currents** below

6.1.10 Exponential Pulses, Pulses with Exponential Rise

type:	monophasic, symmetric, alternating
pulse:	1 to 800 ms
pause:	0.1 to 10 000 ms (monophasic, symmetric; then by the pulse length)
	0.1 to 5 000 ms (alternating; then by the pulse length)
frequency:	0.1 to 900 Hz (monophasic)
	0.1 to 450 Hz (symmetric, alternating)
modulation:	see **Modulation of Currents** below

6.1.11 Combined Pulses

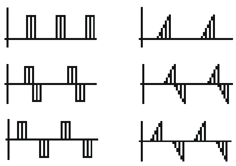


type:	asymmetric
pulse:	0.2 to 1 000 ms
pause:	0.5 to 10 000 ms (depending on the pulse length)
frequency:	0.1 to 550 Hz
modulation:	see **Modulation of Currents** below

6.1.12 Stimulation Pulses (for Stimulations according to Electrodiagnostics)

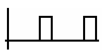
type:	rectangular, triangular (monophasic)
pulse:	0.1 to 1 000 ms
pause:	0.5 to 10 s
pulse generation sound selection:	no (beep depending on the pulse length)

6.1.13 Interrupted Pulses



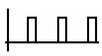
type:	rectangular, triangular (monophasic, symmetric, alternating)
interruption frequency:	8 000 Hz, duty factor 95 %
pulse:	1 to 30 ms
pause:	1 to 60 ms (monophasic)
	1 to 30 ms (symmetric, alternating)
frequency:	11.1 to 500 Hz (monophasic)
	11.1 to 333 Hz (symmetric)
	8.3 to 250 Hz (alternating)
modulation:	see **Modulation of Currents** below

6.1.14 Träbert, Ultra-Reiz 2-5



type:	monophasic
pulse:	2 ms
pause:	5 ms
frequency:	143 Hz
modulation:	see **Modulation of Currents** below

6.1.15 Leduc



type:	monophasic
pulse:	1 ms
pause:	9 ms
frequency:	100 Hz
modulation:	see **Modulation of Currents** below

6.1.16 Faradic, Neofaradic

type: monophasic rectangular (faradic), monophasic triangular (neofaradic)
pulse: 2 ms
pause: 20 ms
frequency: 45.5 Hz
modulation: see **Modulation of Currents** below

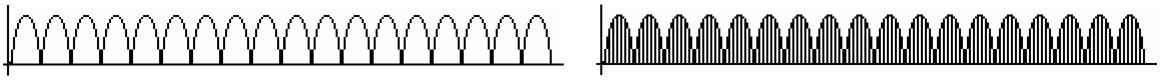
6.1.17 H-wave

type: symmetric
pulse: 2 x 5.6 ms
pause: 0.22 to 10 000 ms
frequency: 0.1 to 87.7 Hz
modulation: see **Modulation of Currents** below

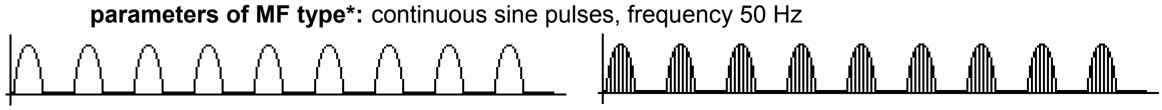
6.1.18 Diadynamics

type: DF, MF, CP, LP, RS, CP-ISO
base: 0 / 0.5 / 1 / 2 / 5 / 10 %
basic frequency: 50 or 60 Hz (from these frequencies the currents were derived)
pulse interruption: 8 000 Hz, duty factor 95 %

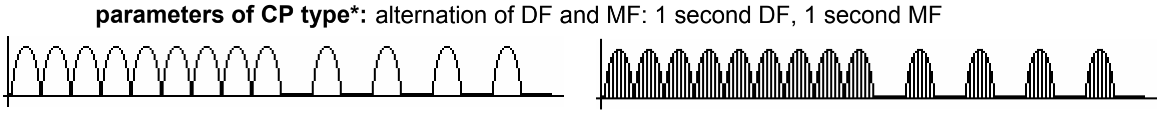
parameters of DF type*: continuous sine pulses, frequency 100 Hz

DF


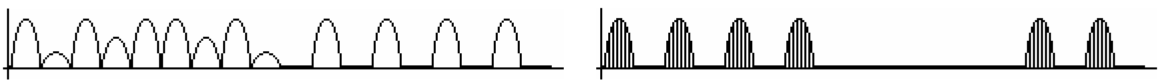
parameters of MF type*: continuous sine pulses, frequency 50 Hz

MF


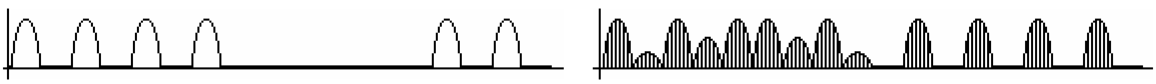
parameters of CP type*: alternation of DF and MF: 1 second DF, 1 second MF

CP


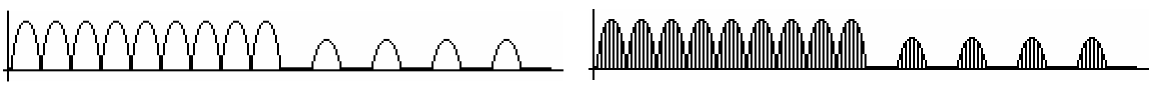
parameters of LP type*: alternation of modulated DF (10 seconds) and MF (6 seconds)

LP


parameters of RS type*: alternation of MF and pause: 1 second MF, 1 second pause

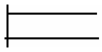
RS


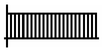
parameters of CP-ISO type*: alternation of DF and MF with the amplitude 80 % of DF: 1 second DF, 1 second MF

CP-ISO


* the parameters are defined for the basic pulse frequency 50 Hz

6.1.19 Galvanic Current (Iontophoretic)



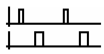


type: continuous, interrupted by 8 000 Hz with duty factor 95 %

6.1.20 Microcurrents

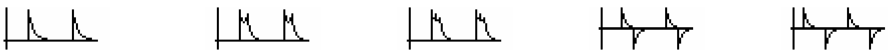
type: rectangular, triangular, exponential (monophasic, symmetric, alternating) and combined
pulse: 0.2 to 1 000 ms (rectangular, combined)
1 to 1 000 ms (other)
pause: 0.1 to 10 000 ms (monophasic, symmetric, combined; then by the pulse length)
0.1 to 5 000 ms (alternating; then by the pulse length)
frequency: 0.1 to 1 000 Hz (rectangular)
0.1 to 700 Hz (combined)
0.1 to 900 Hz (other, monophasic)
0.1 to 450 Hz (other, symmetric a alternating)
modulation: see **Modulation of Currents** below
note: CC mode only

6.1.21 Spastic Stimulations (according to Hufschmidt)



pulses: 0.1 to 25 ms
delay between channels: 10 to 3 000 ms
frequency: 0.15 to 50 Hz (depending on the set pulse length and delay)

6.1.22 High-voltage Therapy (HVT)



type: single-peak, double-peak, triple-peak pulses
symmetric, alternating
pulse: 20 μs (pulses: single, symmetric, alternating)
30 μs (double-peak pulses)
40 μs (triple-peak pulses)
frequency: 0.1 to 500 Hz
modulation: see **Modulation of Currents** below
note: CV mode only

6.2 MODULATION OF CURRENTS

Types:	constant frequency random frequency burst sine surges trapezoid surges symmetric surges
Random frequency:	standard ± 30 %
Burst (not designed for HVT):	
number of bursts in a pulse:	3 to 10
frequency of bursts:	0.1 to 100 Hz (depending on length and freq. of pulses)
Sine surges:	
surge length :	0.15 to 35 s (for HVT from 3 to 35 s)
pause length :	0.02 to 70 s (for HVT from 3 to 70 s)
Trapezoid surges:	
rise, fall:	1 to 35 s (for HVT from 3 to 35 s)
time of stimulation, pause between surges:	1 to 35 s (for HVT from 3 to 35 s)
Symmetric surges:	
sweep time:	1 to 35 s (for HVT from 3 to 35 s)
contour:	1 to 99 %

6.3 FREQUENCY SWEEP (INTERFERENCE)

types:	continuous, jump, symmetric
Random selection of frequency at sweep:	yes/no
Continuous sweep:	
frequency rise and fall:	1 to 35 s
frequency hold:	0 to 35 s
Jump sweep:	
frequency hold:	1 to 35 s
Symmetric sweep:	
sweep time:	1 to 35 s
contour:	1 to 99 %

6.4 STEPS OF SETTING OF PARAMETERS

Steps of setting the parameters of currents*

0.10 to 0.30:	0.01
0.30 to 1.00:	0.05
1.00 to 3.00:	0.10
3.00 to 10.0:	0.5
10.0 to 30.0:	1.0
30.0 to 100:	5
100 to 300:	10
300 to 1 000:	50
1 000 to 3 000:	100
3 000 to 10 000:	500

* applies for all settings except carrier frequency:

2 500 to 5 000:	100
5 000 to 10 000:	500

6.5 MAXIMUM INTENSITY VALUES

TENS:

10 µs to 160 µs 140 mA
161 µs to 400 µs 140 mA (for additional limits see the table)

pulse : pause	frequency 0.1 – 400 Hz	frequency above 400 Hz
100 : 1	50 mA	80 mA
10 : 1	52 mA	83 mA
5 : 1	54 mA	87 mA
2 : 1	61 mA	97 mA
1 : 1	70 mA	113 mA
1 : 2	86 mA	138 mA
1 : 3	100 mA	140 mA
1 : 5	122 mA	140 mA
1 : 7	140 mA	140 mA
1 : 10 to 1 : 10 000	140 mA	140 mA

2-pole interference: 140 mA

4-pole interference: 100 mA

Isoplanar interference: 100 mA

Dipole interference: 100 mA

Russian stimulation: 140 mA

Diadynamics: **DF** 70 mA
MF 100 mA
CP 80 mA
LP 80 mA
RS 100 mA
CP-ISO 80 mA

Rectangular pulses, combined pulses, interrupted rectangular pulses:

0.2 ms to 29 ms 140 mA (for additional limits see the table)*
30 ms to 49 ms 110 mA (for additional limits see the table)*
50 ms to 69 ms 90 mA (for additional limits see the table)*
70 ms to 99 ms 80 mA (for additional limits see the table)*
100 ms to 299 ms 70 mA (for additional limits see the table)*
300 ms to 1000 ms 65 mA (for additional limits see the table)*

pulse : pause	frequency 0.1 – 400 Hz	frequency above 400 Hz
100 : 1	50 mA	80 mA
10 : 1	52 mA	83 mA
5 : 1	54 mA	87 mA
2 : 1	61 mA	97 mA
1 : 1	70 mA	113 mA
1 : 2	86 mA	138 mA
1 : 3	100 mA	140 mA
1 : 5	122 mA	140 mA
1 : 7	140 mA	140 mA
1 : 10 to 1 : 10 000	140 mA	140 mA

* always the lower value is valid

Triangular pulses, interrupted triangular pulses:

1 ms to 29 ms	140 mA (for additional limits see the table)*
30 ms to 49 ms	110 mA (for additional limits see the table)*
50 ms to 69 ms	90 mA (for additional limits see the table)*
70 ms to 99 ms	80 mA (for additional limits see the table)*
100 ms to 299 ms	70 mA (for additional limits see the table)*
300 ms to 1000 ms	65 mA (for additional limits see the table)*

pulse : pause	frequency 0.1 – 400 Hz	frequency above 400 Hz
100 : 1	71 mA	113 mA
10 : 1	74 mA	118 mA
5 : 1	77 mA	123 mA
2 : 1	86 mA	138 mA
1 : 1	100 mA	140 mA
1 : 2	122 mA	140 mA
1 : 3 to 1 : 10 000	140 mA	140 mA

* always the lower value is valid

Exponential pulses, pulses with exponential rise, interrupted exponential pulses:

1 ms to 29 ms	140 mA (for additional limits see the table)*
30 ms to 49 ms	110 mA (for additional limits see the table)*
50 ms to 69 ms	90 mA (for additional limits see the table)*
70 ms to 99 ms	80 mA (for additional limits see the table)*
100 ms to 299 ms	70 mA (for additional limits see the table)*
300 ms to 800 ms	65 mA (for additional limits see the table)*

pulse : pause	frequency 0.1 – 400 Hz	frequency above 400 Hz
100 : 1	87 mA	138 mA
10 : 1	90 mA	140 mA
5 : 1	94 mA	140 mA
2 : 1	106 mA	140 mA
1 : 1	122 mA	140 mA
1 : 2 to 1 : 10 000	140 mA	140 mA

* always the lower value is valid

Stimulation pulses:

0.1 ms to 29 ms	140 mA (for additional limits see the table)*
30 ms to 49 ms	110 mA (for additional limits see the table)*
50 ms to 69 ms	90 mA (for additional limits see the table)*
70 ms to 99 ms	80 mA (for additional limits see the table)*
100 ms to 299 ms	70 mA (for additional limits see the table)*
300 ms to 1000 ms	65 mA (for additional limits see the table)*

Träbert current (Ultra-Reiz): 92 mA

Leduc current: 140 mA

Faradic current: 140 mA

Neofaradic current: 140 mA

Galvanic current: 65 mA

H – wave:

frequency	intensity
0.1 – 35 Hz	140 mA
40 Hz	129 mA
50 Hz	114 mA
60 Hz	103 mA
80 Hz	90 mA
88 Hz	86 mA

Microcurrents: 1000 µA

Spastic stimulation: 140 mA

HVT: 390 V